3-D Stress Generation and Relaxation in Ge Nanocrystals

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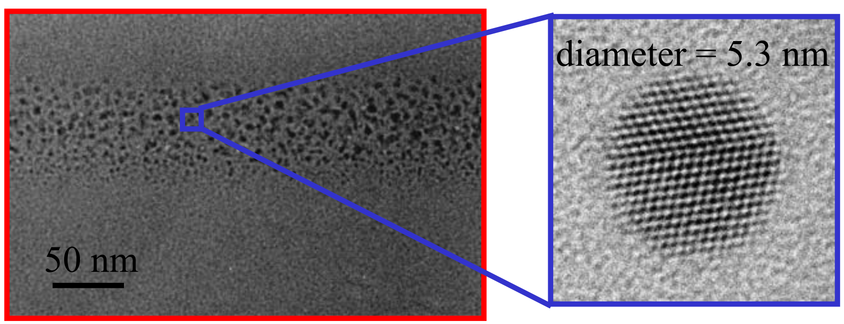
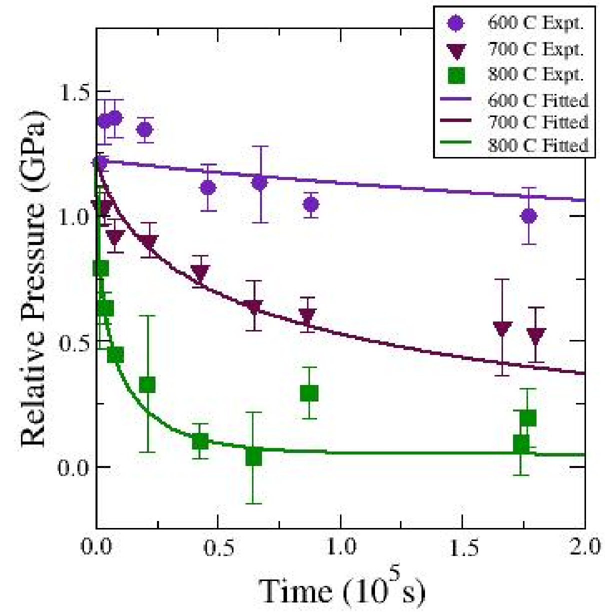
Research Goal: To determine the mechanisms contributing to three-dimensional stress evolution in germanium nanocrystals. Ultimately, methods of controlling these stresses for self-assembly and functional tunability will be explored.



Transmission electron microscope images of nanocrystals embedded in silicon dioxide synthesized by Ge ion implantation and high temperature annealing. On the left, a band of nanocrystals with diameters between 2 nm and 8 nm are observed. The image on the right shows an individual nanocrystal 6 nm in diameter.



Plot of the pressure in Ge nanocrystals as a function of post-growth annealing conditions. Pressure was determined using Raman spectroscopy. A theoretical model for stress relaxation was developed and provides a good description of the experimental observations. Further experiments are required to describe the origins of compressive stress.

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Education: Four graduate students, (Chris Liao, Ian Sharp, and Qing Xu, and Diana Yi) have contributed to this project at the University of California at Berkeley. Working at the National Center for Electron Microscopy (NCEM), Q. Xu has learned to perform a variety of advanced Transmission Electron Microscopy (TEM) techniques. C. Liao and I. Sharp have gained extensive experience with the synthesis, processing, and characterization (both electronic and optical) of nanostructures. D. Yi has developed comprehensive theoretical models describing the nucleation and growth of the nanocrystals and the effects of post-processing on nanocrystal properties.

Broader Impact: The advancement of nanoscale science and technology is expected to have a great impact on a diverse range of fields. As dimensions shrink, new challenges in manipulation and measurement arise that must be overcome. A primary goal of this project is to develop characterization and processing techniques that will allow for continued miniaturization.